AAIC 23rd Annual Meeting
Challenges and Opportunities for Industrial Crops
Fargo, North Dakota, USA ~ September 11 - 14, 2011

Agronomic evaluation of Guayule cultivation in two Mediterranean areas (Spain and France)

D. Snoeck, E.N. van Loo, T. Chapuset, S. Palu

cirad
AGRICULTURAL RESEARCH FOR DEVELOPMENT

EU-PEARLS FP7

WAGENINGEN UR
For quality of life

Objective of this study

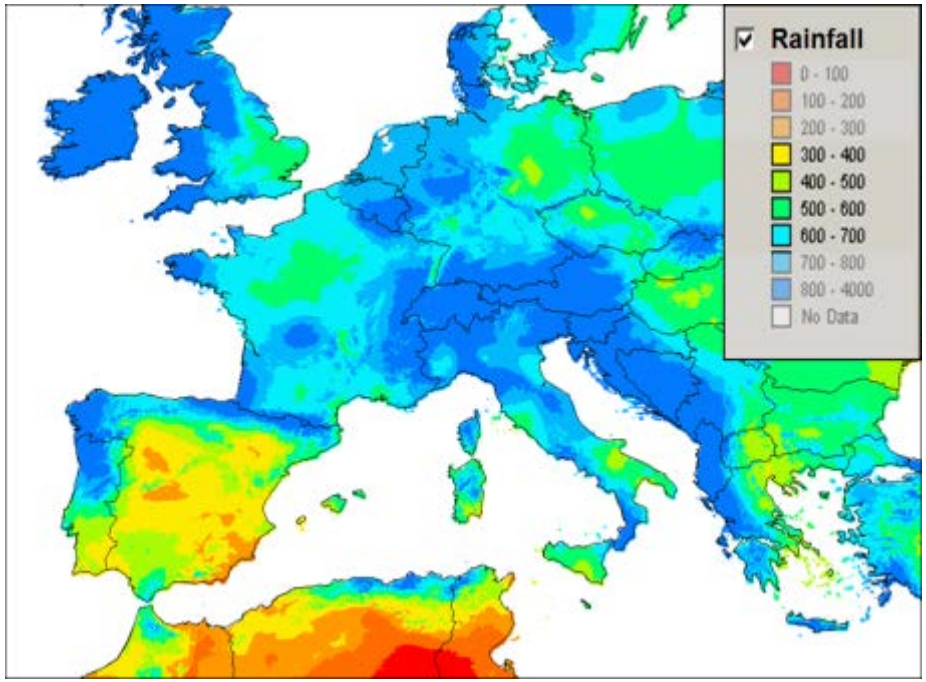
- Determine the viability of guayule cultivation in the Mediterranean regions of Southern Europe for a possible development of large-scale production.

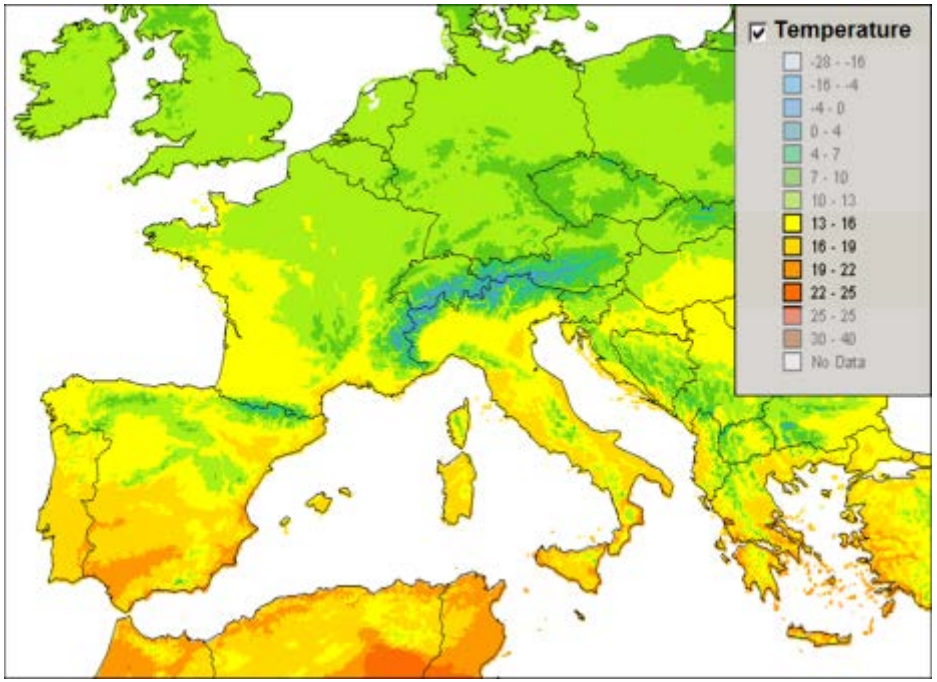
Temperature and water resources are the major climate factors that govern the distribution of crops, both in space and time.

Guayule is native to the Mexican desert, where:

- average annual rainfall is 300 to 600 mm;
- average annual temperatures is 16 to 25 °C.

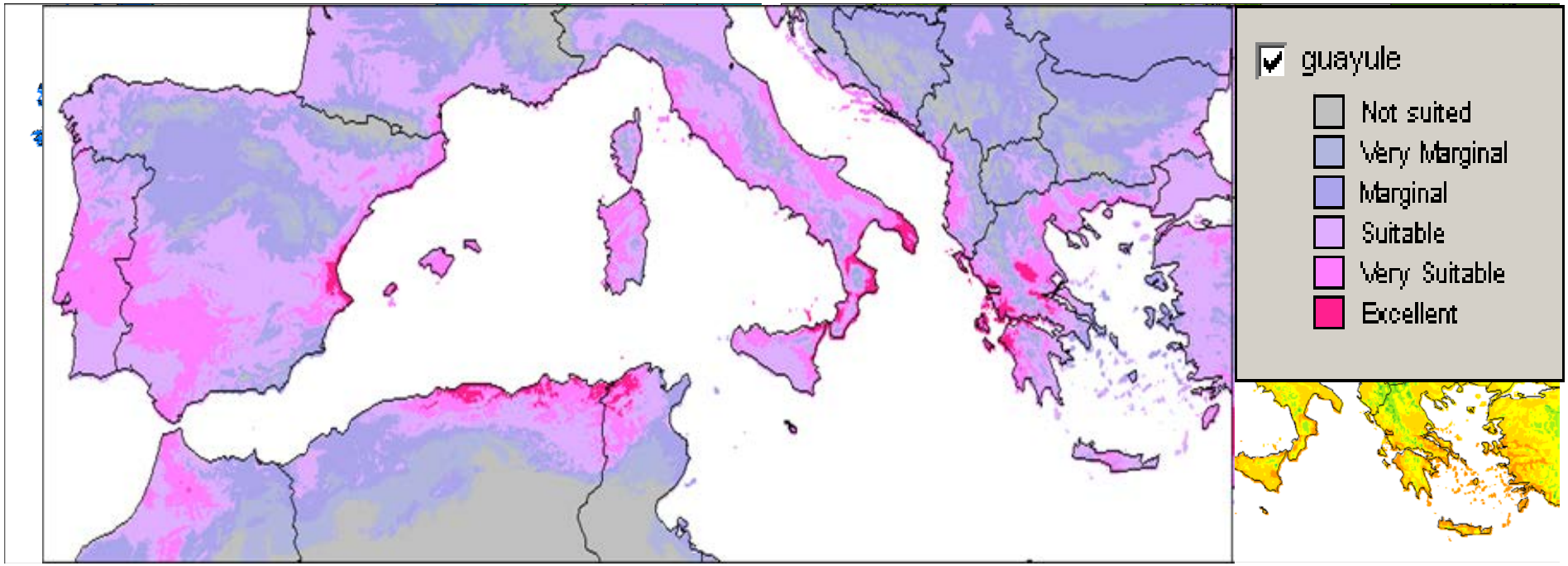
These conditions can be found in the Mediterranean region.





We used a GIS to combine the two maps, and generate a potential land suitability map for guayule.

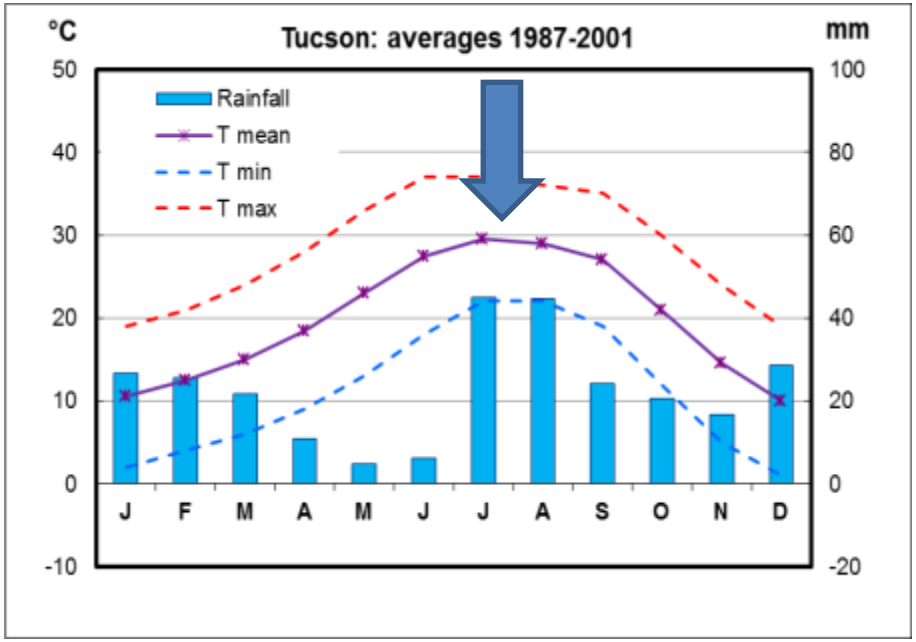
The final result is a map showing six potential yield categories, with better notation where optimal conditions exist.



But, the rainfall patterns are different in the region of origin and in the Mediterranean region.

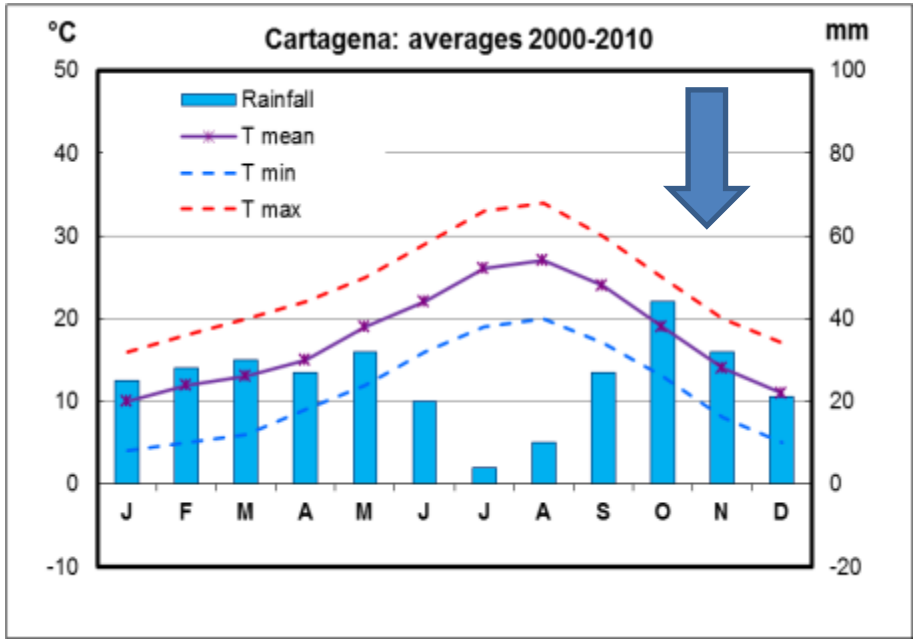
Tucson (Arizona, USA)

9 dry months ($P_{mm}/T_{°C} < 2$)
Annual rainfall = 280 mm



Cartagena (Murcia, Spain)

7 dry months ($P_{mm}/T_{°C} < 2$)
Annual rainfall = 300mm



Thus, the need for field trials in Europe

Site selection

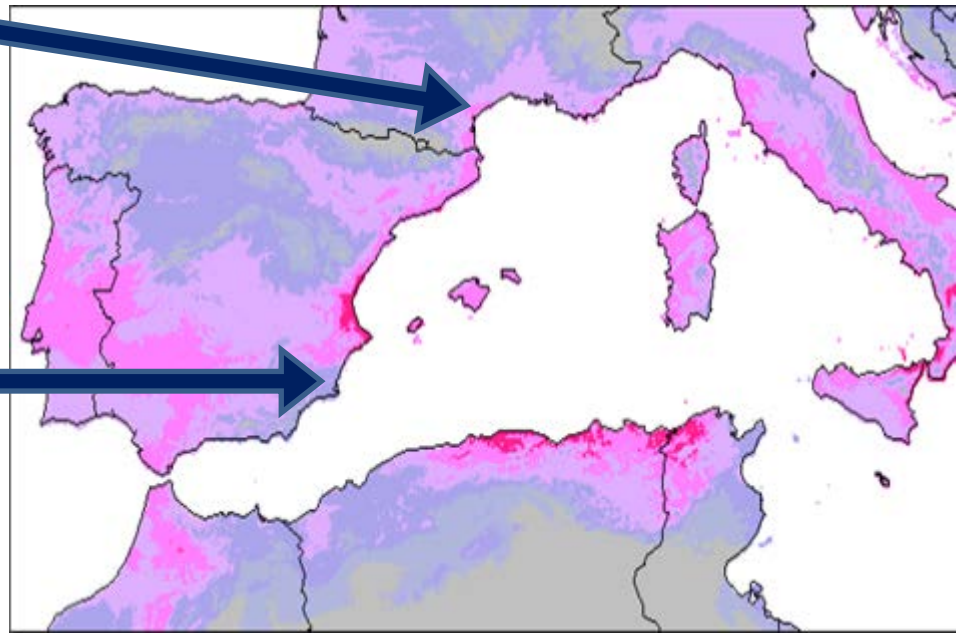
Two sites were selected for field trials:

- France, Montpellier
  Agropolis research station

cirad
AGRICULTURAL RESEARCH FOR DEVELOPMENT

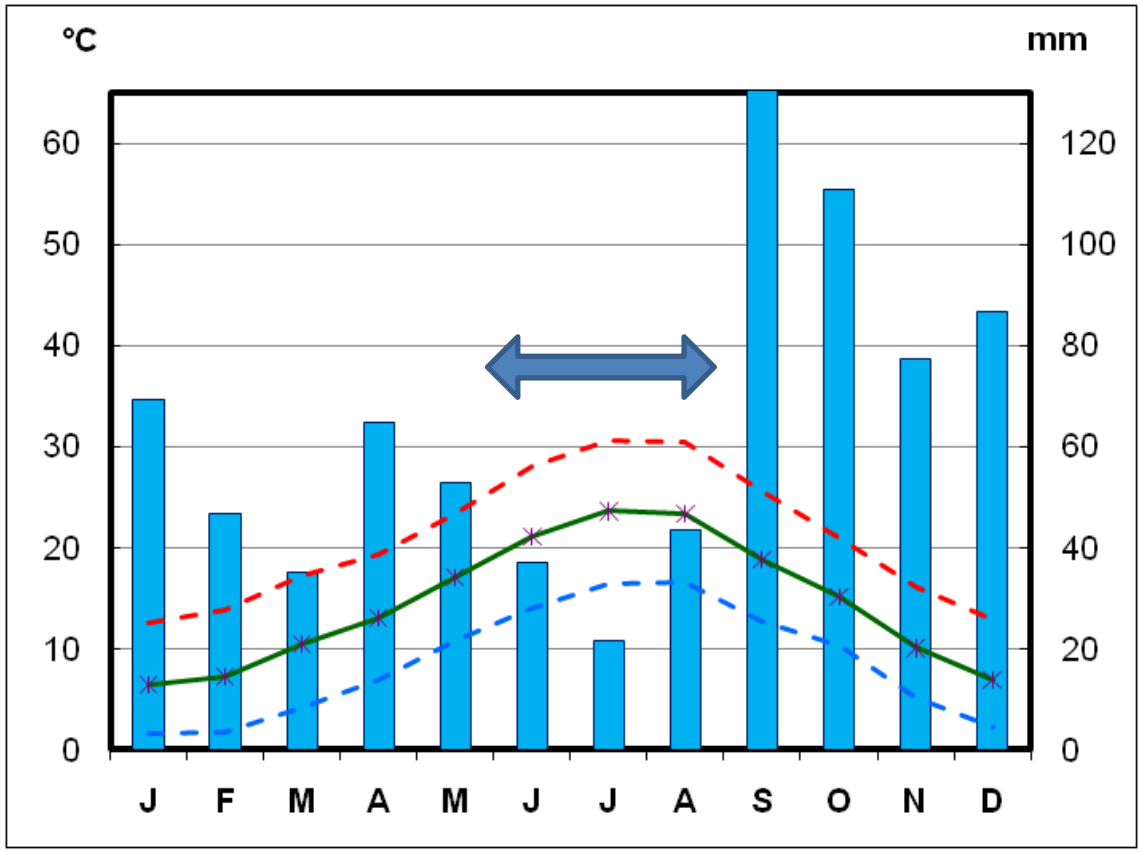
- Spain, Cartagena
  El Molinar farm

WAGENINGEN UR
For quality of life



Montpellier Climatic data

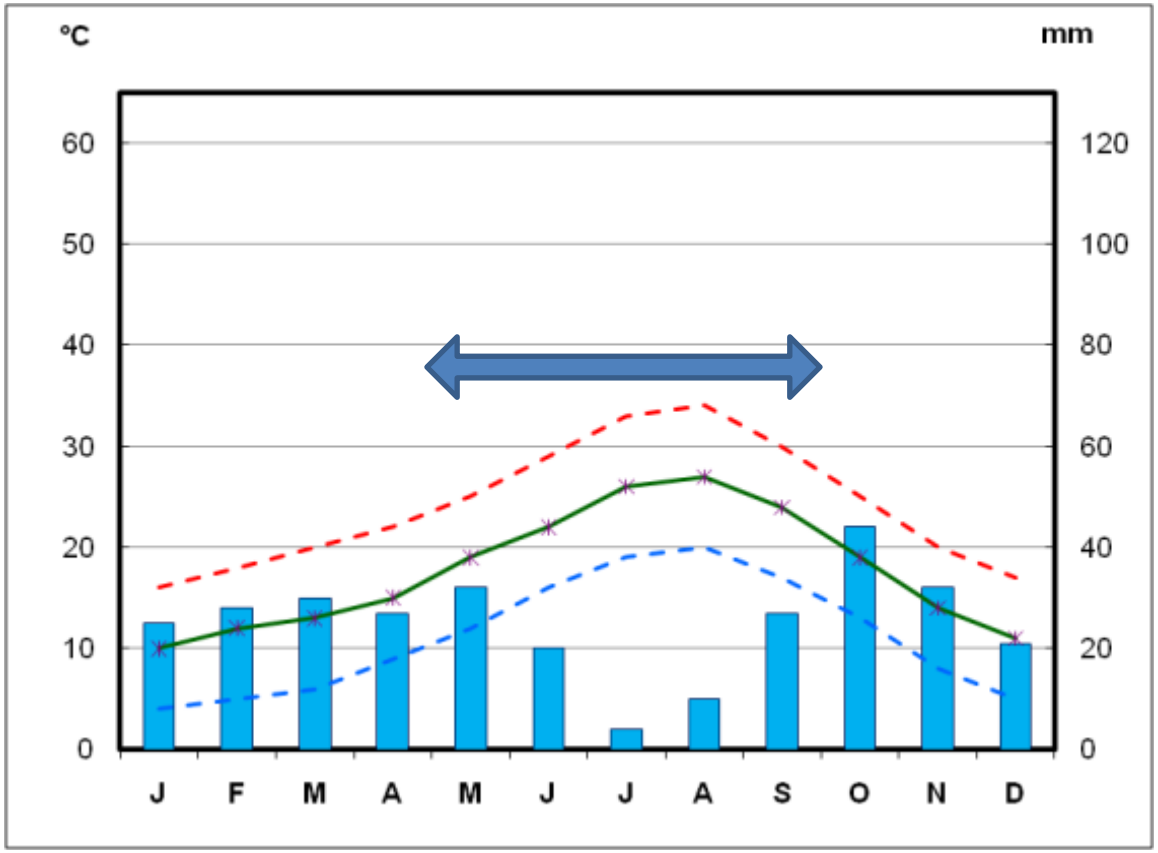
- Average temperature in Winter = 5 - 7 °C; in Summer = 21 - 24 °C
- Total annual rainfall = 776 mm, with 3 dry months ($P_{mm}/T_{°C} < 2$).



Average over last 20 years

Cartagena climatic data

- Average temperature in Winter = 10 - 12 °C, in Summer = 22 - 28 °C
- Total annual rainfall = 300 mm, with 7 dry months ($P_{mm}/T_{°C} < 2$)



Two trials in the two sites

- Germplasm:
  - Which cultivars for which region.
  - Produce the seeds of the locally selected cultivars.

- Irrigation + Fertilization :
  - Study the influence of these two major farming practices.

Germplasm trial
Materials

The seeds were provided by the University of Arizona, USDA, and Yulex. The cultivars were of:

- Mexican origin (Coahuila, Zacatecas),
- U.S. origin (Arizona, California, and Texas).

During the 1st year of the EU-Pearls project (2008), we planted :

- 40 cultivars in France,
- 24 cultivars in Spain.

Germplasm trial
Materials and Methods

- Planting design:
  - Elementary plots = 1 line / cultivar
    - 2 border lines and 2 border plants.

Observations:

Germination rate,

Height,

Weight of plant parts

(stems, leaves, and roots),

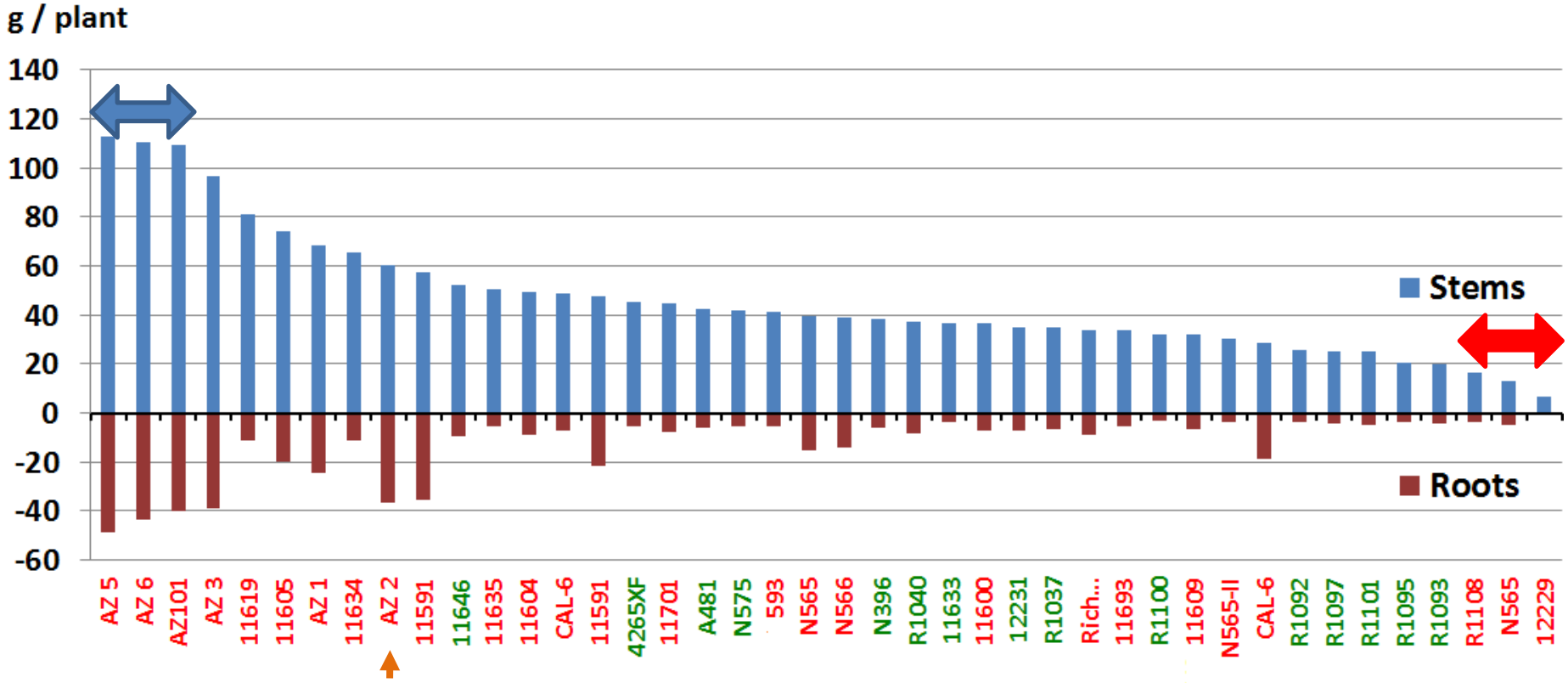
Plant uniformity,

Winter tolerance (for Montpellier),

Rubber & resin contents in October and March, each year.

Germplasm evaluation Results (*Montpellier*)

- Dry Matter: stems and roots (at 12 months)



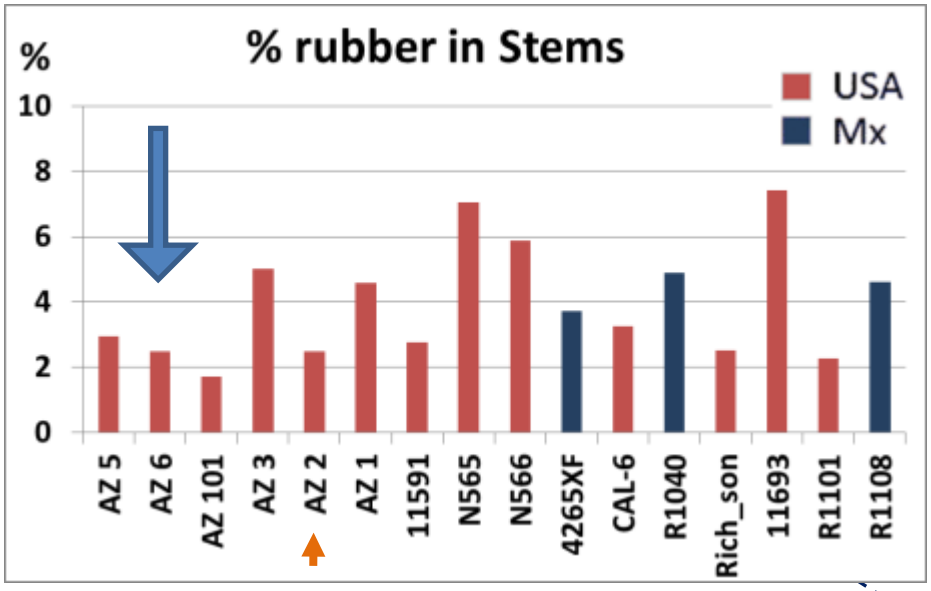
Cultivar origins: USA (red) Mexico (green)

(Planting density = 50,000 plants/ha → 3 cvrs > 5 tons stems/ha)

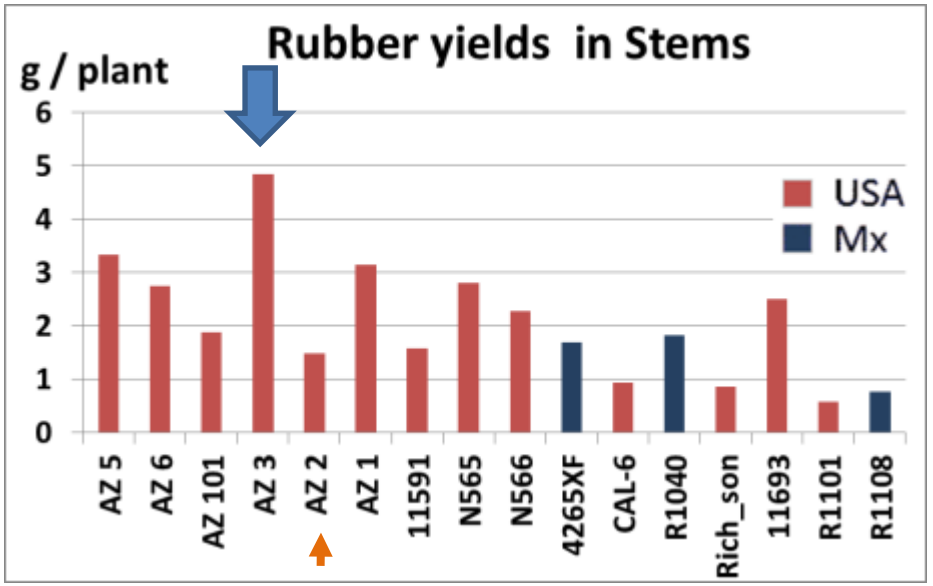
Germplasm evaluation Results (*Montpellier*)

Rubber content in stems of some varieties,

in %



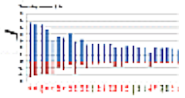
in g/plant



Rubber content in stems:
average = 3.98 %

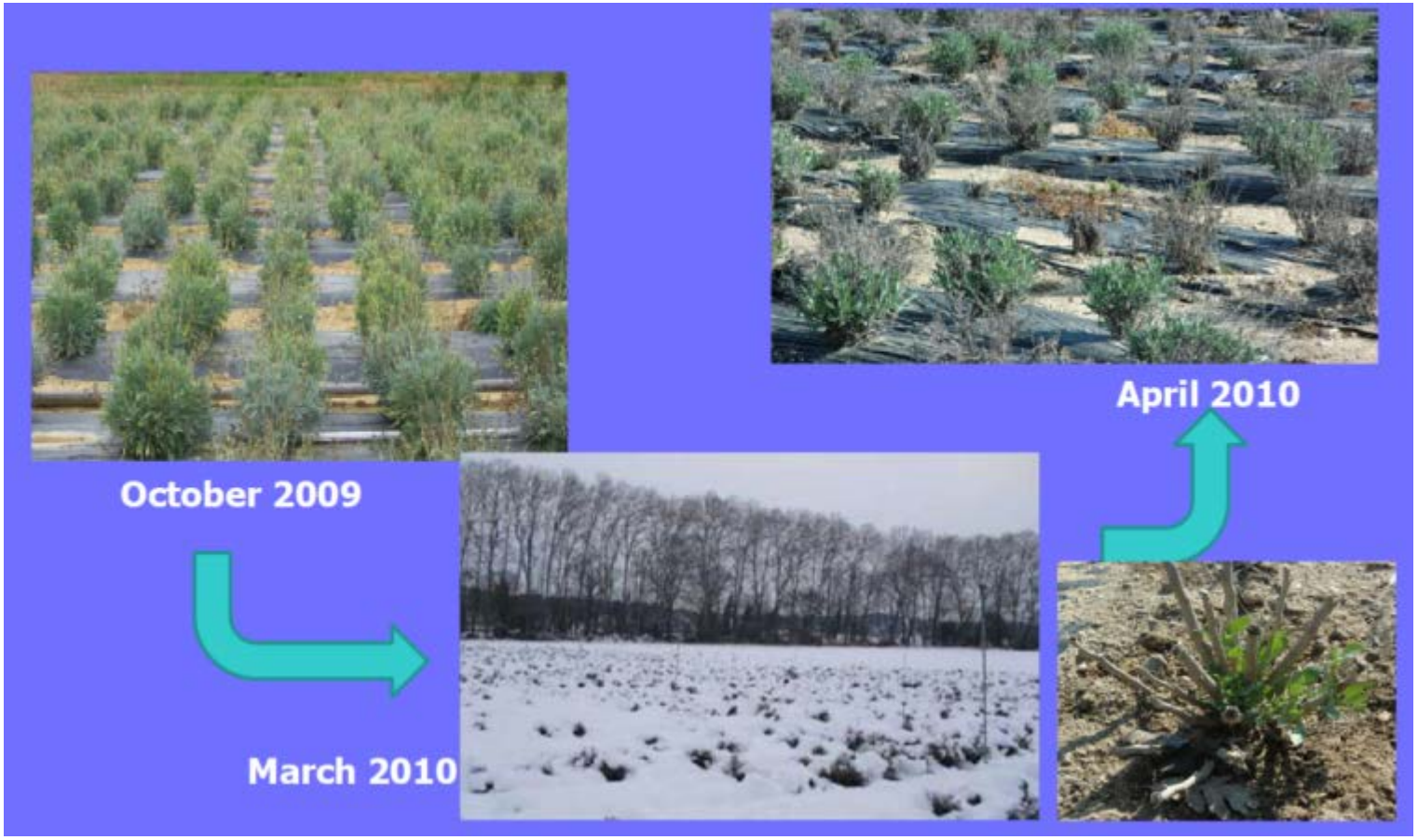
Rubber Yields:
% rubber × Kg dry matter

(12 months old)



Montpellier Climatic data

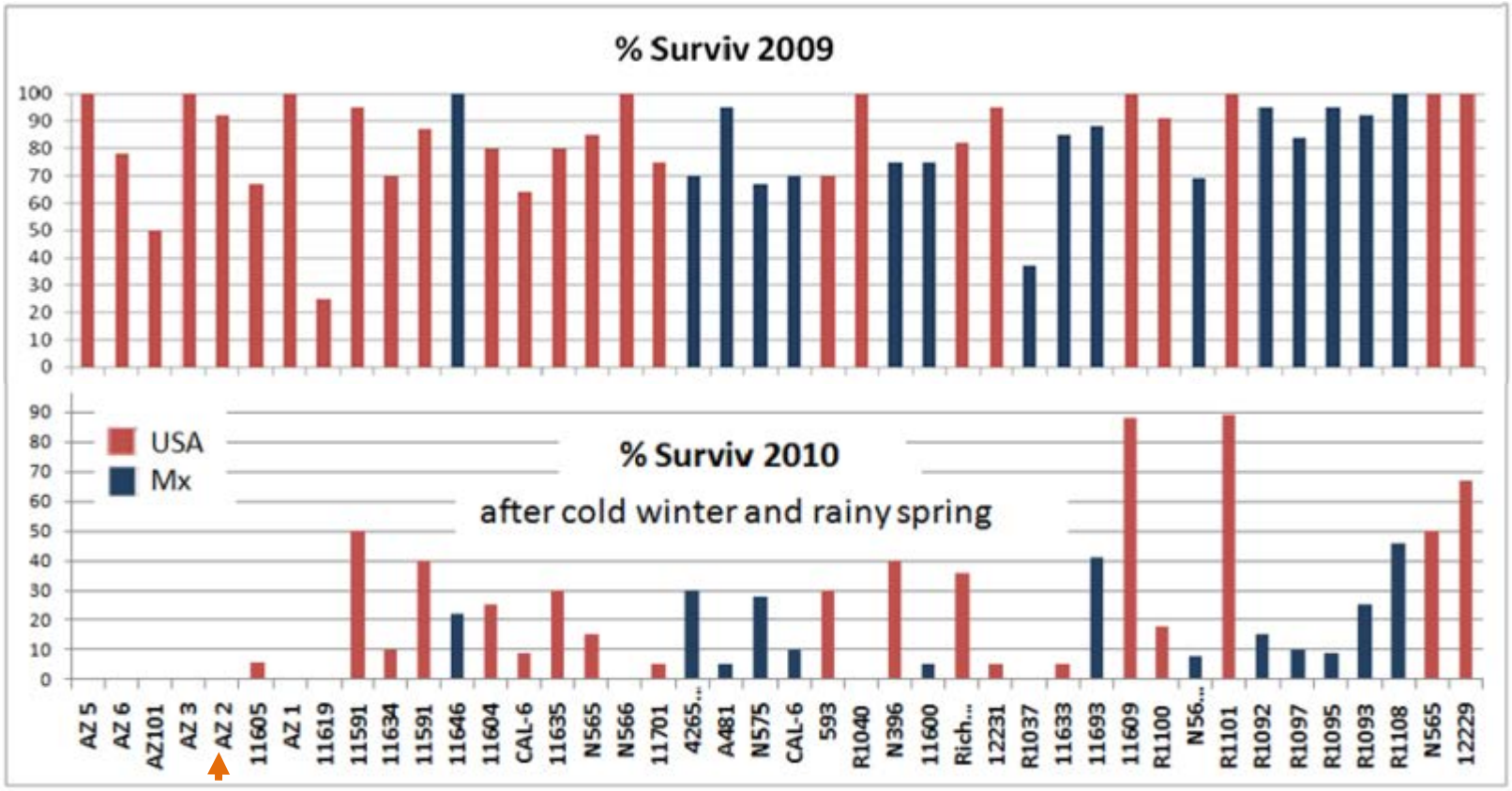
The 2009-2010 winter was much colder and rainier than average with 53 days below 0°C. The lowest temperature was = – 8.1 °C (on Dec. 16th).



- Average temperature in Winter = 5 – 7 °C; in Summer = 21 - 24 °C
- Total annual Rainfall = 776 mm, with 3 dry months ($P_{mm}/T_{°C} < 2$).

Germplasm evaluation Results (*Montpellier*)

Survival rates after 1 year and after 2 years

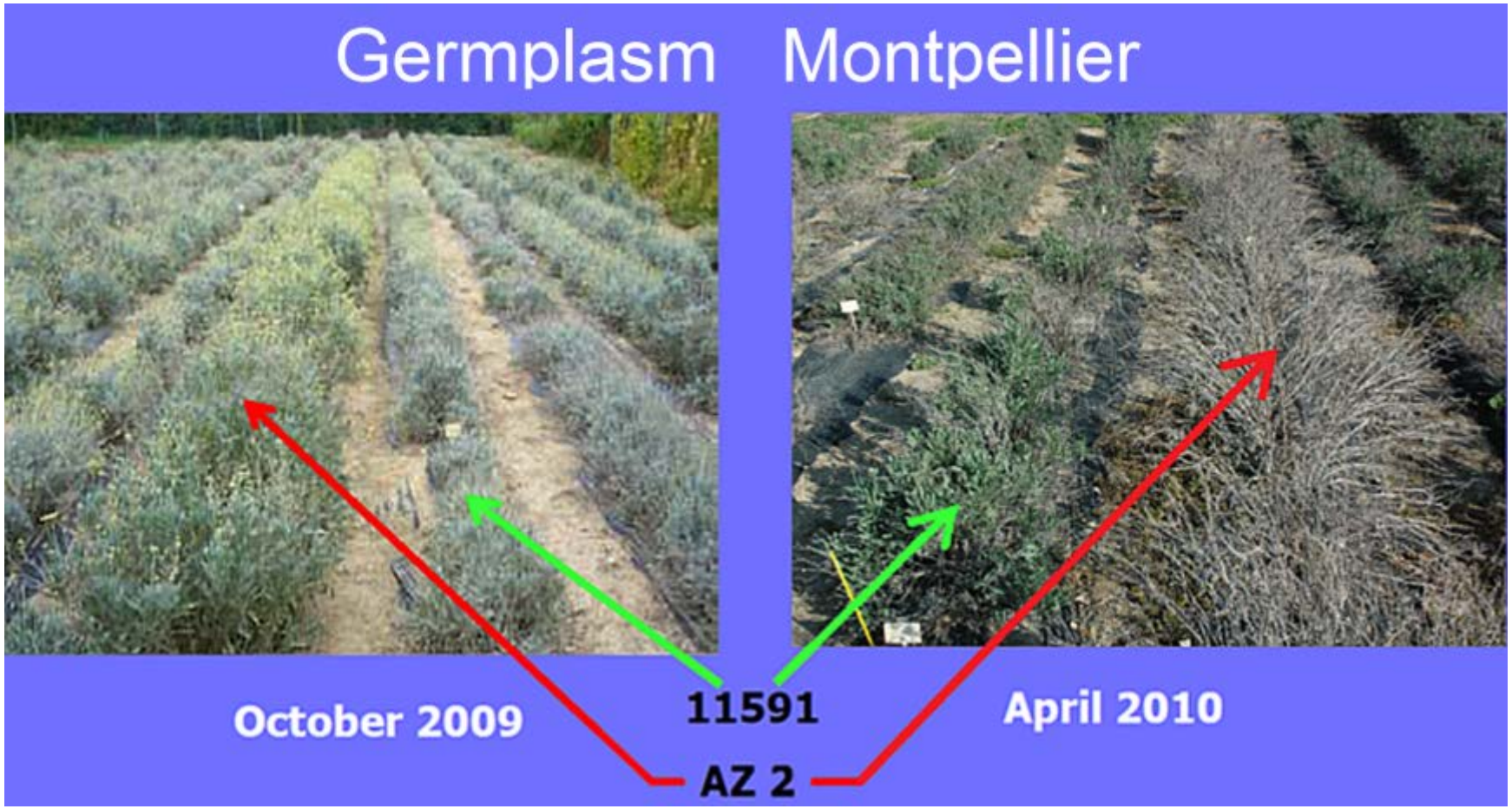


In 2009: 100 % of lines survived with No plants/line = 25% to 100%

In 2010: 76 % of lines survived with No plants/line = 5% to 88%

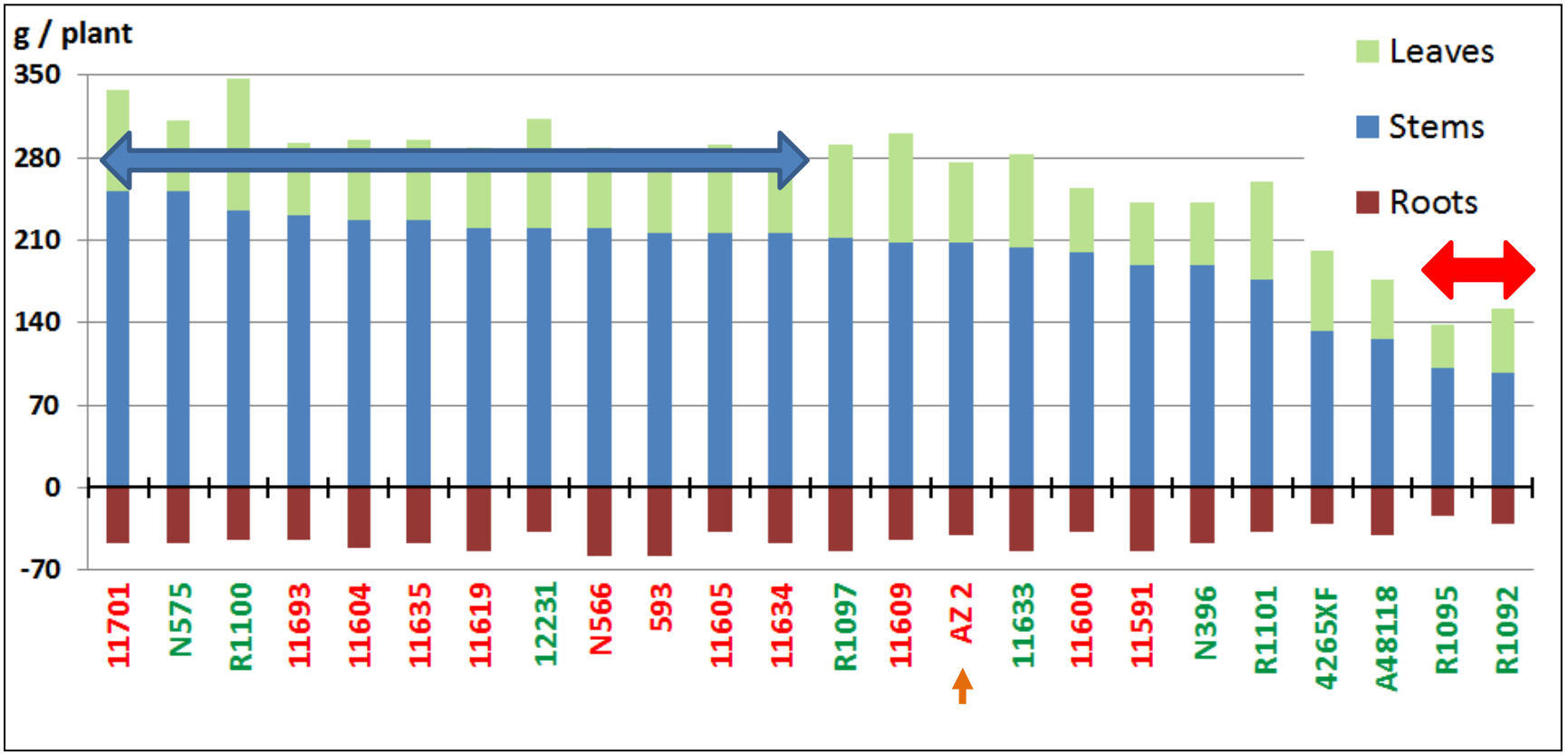
Germplasm evaluation Results (*Montpellier*)

Influence of climate on 2 particular cultivars: The case of winter in Montpellier



Germplasm evaluation Results (*Cartagena*)

Dry matter yields: significant variations were observed at 12 months after planting



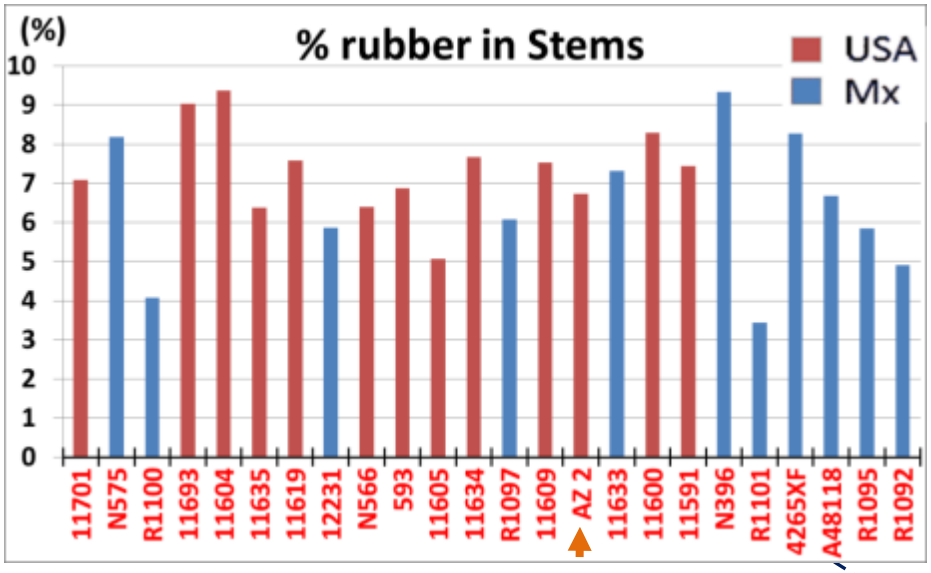
Cultivar origins: USA (red) ; Mexico (green)

(Planting density = 50,000 plants/ha → 12 cvrs > 10 tons stems*/ha)*

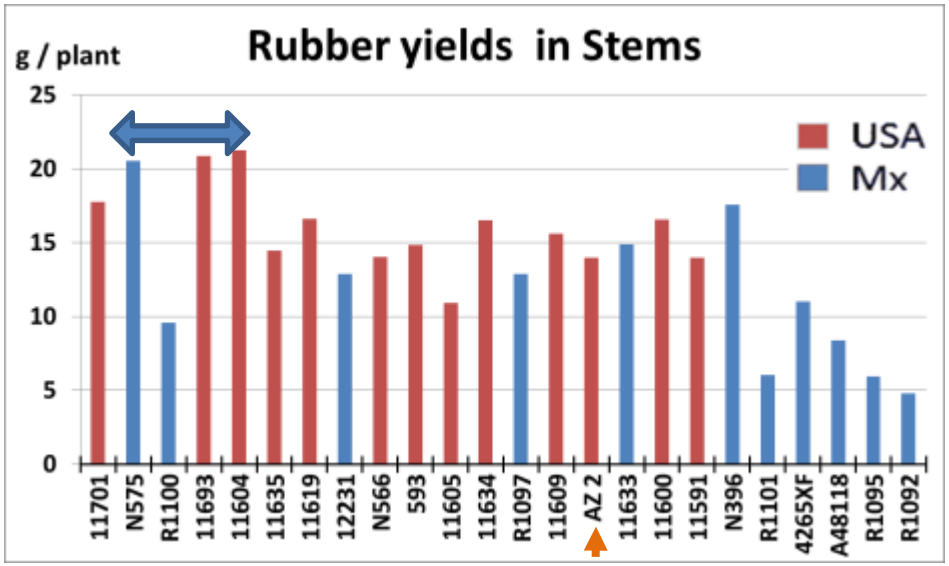
Germplasm evaluation Results (*Cartagena*)

Rubber content in stems of some varieties,

in %



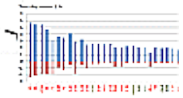
in g/plant



Rubber content in Stems:
average = 6.89 %

Rubber Yields:
% rubber × Kg dry matter

(Planting density = 50,000 plants/ha → ***3 Cvrs > 1,600 kg latex / ha****)*



Germplasm: Conclusions

- The best available subsets of guayule lines from U.S. and Mexico have been selected in two different situations.
- Growing and overwintering of the different lines of the germplasm need to be continued in **Montpellier**.
- Seeds harvested in 2009 could be used to plant further trials (→ fertilization & irrigation).

Fertilization & irrigation trial
Material & Methods

- Statistical design:
  - **1 variety**: AZ 2.
  - **Irrigation**:

    3 levels (100%, 66%, 33%) *at 100% fertilization*.
  - **Fertilization**:

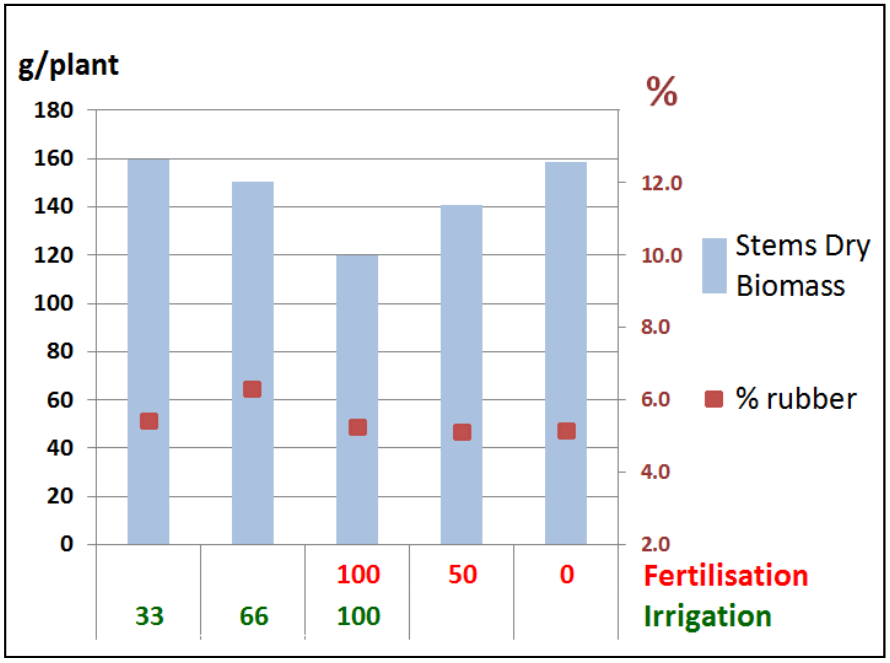
    3 levels (100g, 50g, 0) of NPK *at 100% irrigation*.

- Observations:
  - Height and weight (biomass) of plant parts;
  - Soil fertility and humidity;
  - Number of plants after summer and winter *(in Montpellier)*;
  - Rubber & resin contents (October and March).

- Two sites: Montpellier & Cartagena

Fertilization & irrigation trial results (Montpellier)

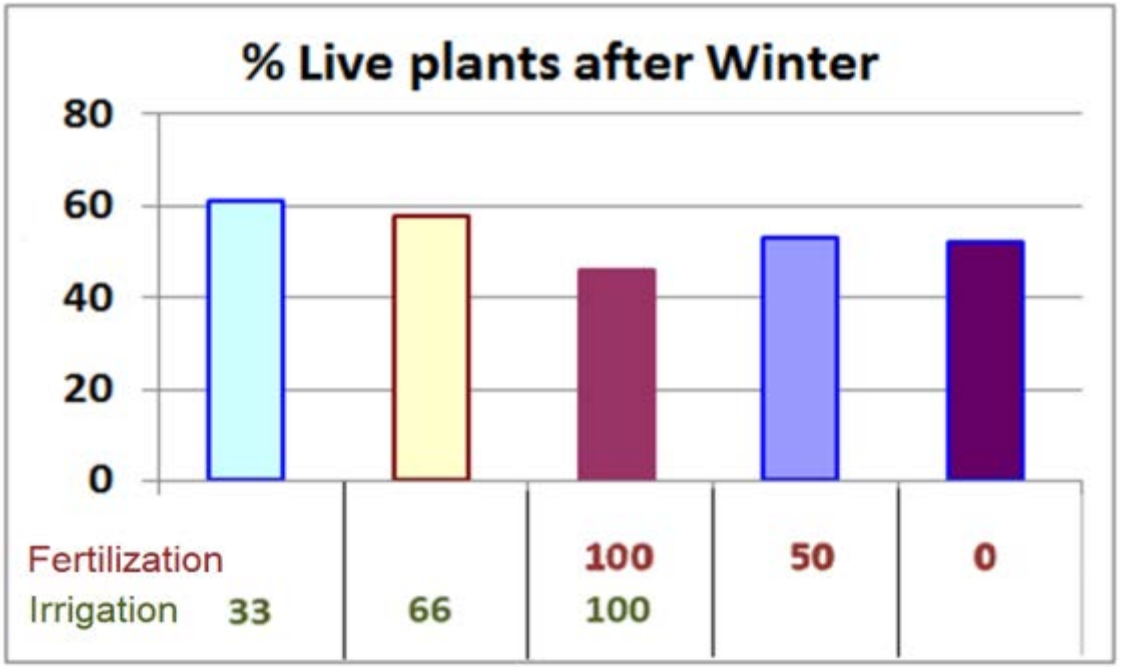
- Average Stems dry biomass and % rubber.



- Less irrigated plots had better yields.
- Less fertilized plots had better yields.
- % rubber was not statistically different between treatments *(average = 5 %)*.

Fertilization & irrigation trial results (Montpellier)

- Surviving plants after cold winter

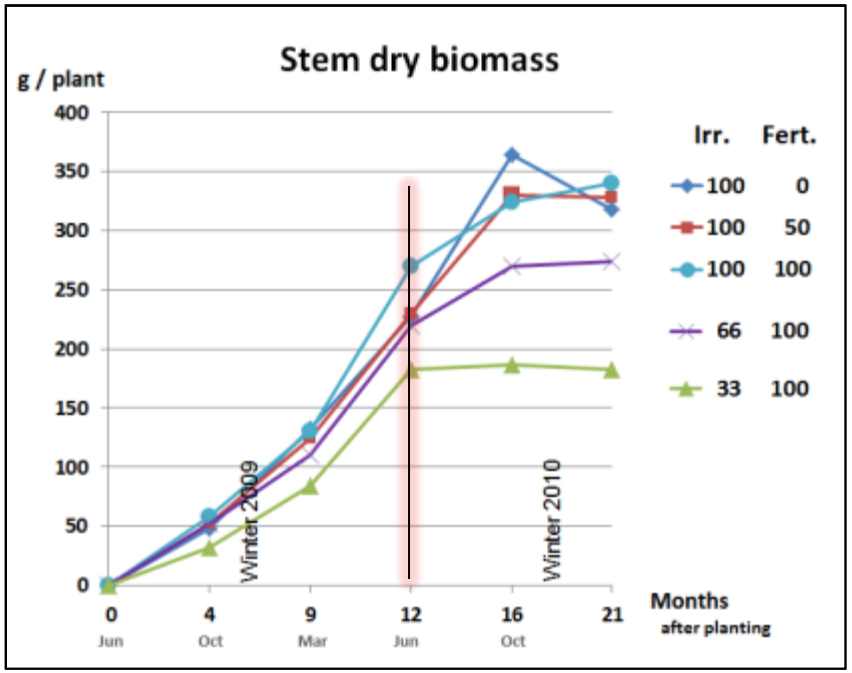


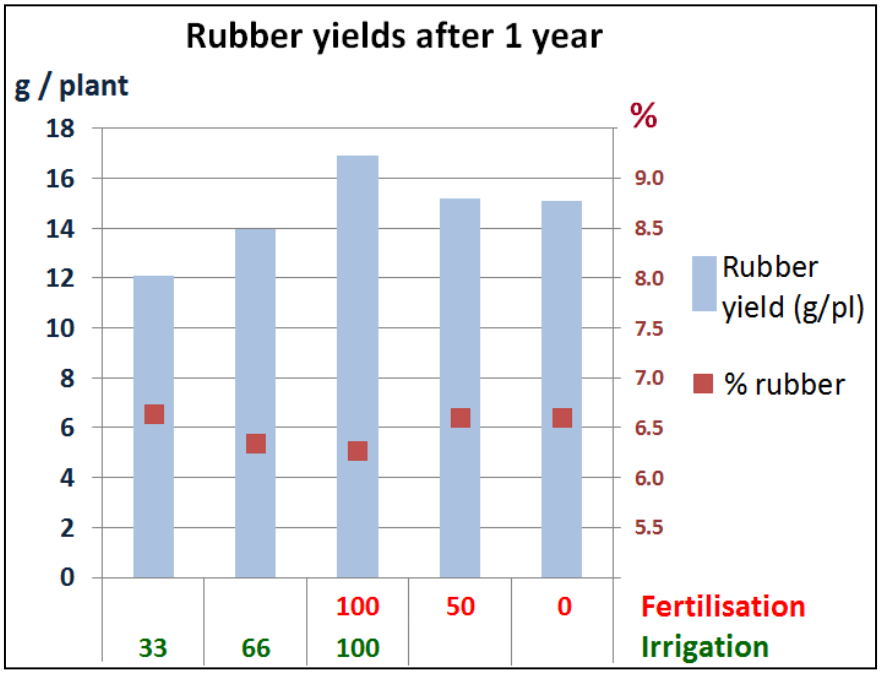
Planted: April 2009

In Montpellier: - Less irrigation produced significantly better survival rates.
- Less fertilization did not produced statistically different survival rates.

Fertilization & irrigation trial results (Cartagena)

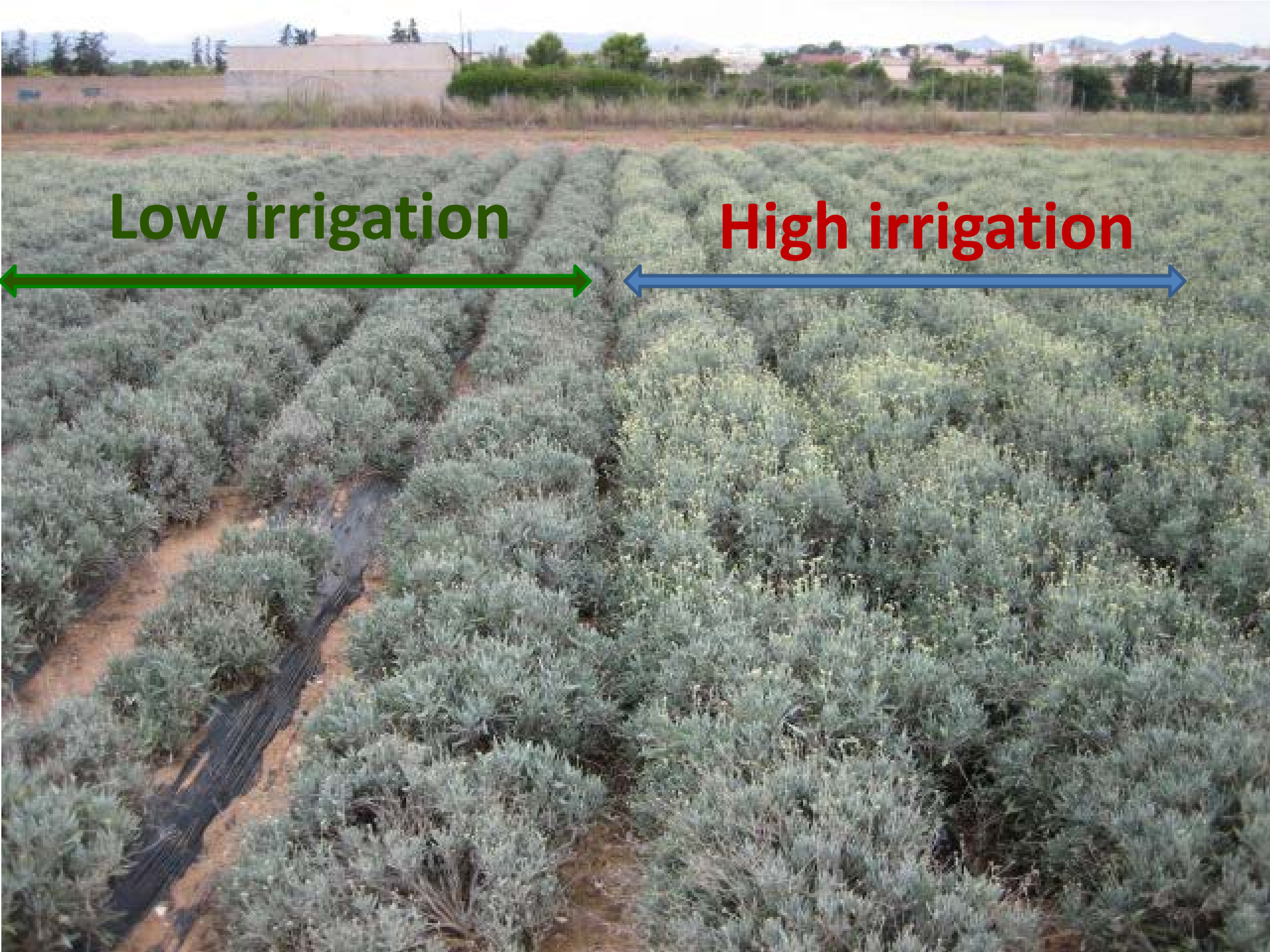
- No significant effect of NPK at this stage.
- Irrigated plots had significantly higher yields.





The average % rubber was 6.5% (*with no statistical differences between treatments*).

Yields are computed from 5 plants / treatment, in a field density of 50,000 plants/ha (with AZ 2)


Low irrigation
High irrigation

Conclusions

Montpellier

- Guayule is **not yet** adapted for commercial cultivation :
  - Some winters can be too cold and rainy.
  - Irrigation was not necessary because rainfall is already high.

- **Results were:**
  - Poor growth (< 8 tons total dry biomass / ha / year);
  - High mortality;
  - Low rubber content (< 4 % of stems DM).

< 450 kg latex / ha / year

Conclusions

Cartagena

- Guayule is **well adapted** to the climatic conditions:
  - The dry climate can be compensated by irrigation.
  - Fertilization is not yet recommended.

- **Resulting in** plants perfectly adapted:
  - Good yields (up to 25 tons total dry biomass / ha / year);
  - No mortality;
  - Good rubber content (> 9 % of stems DM)

up to 1,600 kg latex / ha / year

Thank you
for your attention